

CLAIMS

1. A method for estimating curvilinear distance within a region
5 where a craft with limited maneuverability is traveling and which contains
potential obstacles to be circumvented, which region is referred to as travel
region, in which a map of distances is established covering the travel region
and having as origin of the distance measurements the instantaneous
position (S) of the craft, characterized in that it consists, when the distance
10 map is established, in completing the potential obstacles to be circumvented
(10, 11) by an additional obstacle to be circumvented (20), placed in the
neighborhood of the craft and associated with the craft, cataloging areas of
the near neighborhood of the craft considered to be inaccessible to the craft
owing to its limited maneuverability.

15

2. The method as claimed in claim 1, characterized in that the
additional obstacle (20) is of concave shape and disposed in the
neighborhood of the instantaneous position (S) of the craft in such a manner
that its concavity is turned into the direction of the motion of the craft and
20 encompasses the instantaneous position (S) of the craft.

3. The method as claimed in claim 1, characterized in that the
additional obstacle (20) is U-shaped, the opening of the U being turned into
the direction of the motion of the craft and encompassing the instantaneous
25 position (S) of the craft.

4. The method as claimed in claim 1, characterized in that the
additional obstacle has a half-moon shape, the opening of the half-moon
being turned into the direction of the motion of the craft and encompassing
30 the instantaneous position (S) of the craft.

5. The method as claimed in claim 1, characterized in that the
additional obstacle (figures 7, 8, 9) has a dual-lobed butterfly-wing shape,
placed on either side of the instantaneous position (S) of the craft and having
35 a common tangent oriented in the direction of motion of the craft.

6. The method as claimed in claim 1, characterized in that, when the craft is an aircraft, the contour of the additional obstacle comprises parts corresponding to the ground projections of two circles (30, 31) associated with the aircraft, having a radius equal to the radius of curvature of the tightest turn allowed for the aircraft at the time being considered.

7. The method as claimed in claim 1, characterized in that, when the craft is an aircraft subject to a cross-wind, the contour of the additional obstacle comprises parts of a cycloid (figure 7) corresponding to the ground projections of two circles (30, 31) associated with the aircraft, having a radius equal to the radius of curvature of the tightest turn allowed for the aircraft at the time being considered.

8. The method as claimed in claim 1, characterized in that, when the craft is an aircraft subject to a cross-wind, the contour of the additional obstacle consists of two lobes of a cycloid (40, 40') limited to their parts going from their starting point, which is the instantaneous position (S) of the aircraft, to their second intersection (P, P') with the straight lines (41, 41') going from the instantaneous position (S) of the aircraft to virtual positions (P, P') on the cycloid lobes (40, 40') corresponding, for the aircraft, to an arbitrary track modification angle.

9. The method as claimed in claim 1, characterized in that, when the craft is an aircraft subject to a cross-wind, the contour of the additional obstacle consists of two lobes of a cycloid (40, 40') limited to their parts going from their starting point, which is the instantaneous position (S) of the aircraft, to their second intersection (P, P') with the straight lines (41, 41') going from the instantaneous position (S) of the aircraft to virtual positions (P, P') on the cycloid lobes corresponding, for the aircraft, to a track modification angle of 180 degrees.

10. The method as claimed in claim 1, characterized in that, when the craft is an aircraft subject to a cross-wind and the distance map is established within a geographical reference frame using longitudes and

latitudes, the contour of the additional obstacle (figure 7) has two parts (40, 40') in the form of cycloid lobes obeying the system of parametric equations:

$$\begin{pmatrix} x \\ y \end{pmatrix}_g = \begin{pmatrix} WS_{x_g}.t - \delta.R.\cos(\omega t + \gamma_g) + C_{x_g} \\ WS_{y_g}.t + R.\sin(\omega t + \gamma_g) + C_{y_g} \end{pmatrix}$$

5 x and y being the abscissae and ordinates of a point in the geographical reference frame of the distance map,

$\begin{pmatrix} WS_x \\ WS_y \end{pmatrix}$ being the wind vector expressed in the geographical reference frame

of the distance map,

with

$$10 \quad R = \frac{TAS^2}{g \cdot \tan \varphi_{roll}}$$

$$\omega = \frac{TAS}{R} = \frac{g \cdot \tan \varphi_{roll}}{TAS}$$

TAS being the amplitude of the airspeed of the aircraft,

φ_{roll} being the roll angle of the aircraft during the maneuver,

15 γ being a factor that depends on the initial conditions,

δ being a coefficient equal to +1 for a right turn and -1 for a left turn, and

with

$$C_{x_g} = Long + \delta.R.\cos(\gamma_g)$$

$$C_{y_g} = Lat - R.\sin(\gamma_g)$$

$$20 \quad \gamma_g = \delta.Hheading + k.\Pi$$

Long being the longitude of the instantaneous position of the aircraft,

Lat being the latitude of the instantaneous position of the aircraft, and

Hheading being the flight direction of the aircraft.

25 11. The method as claimed in claim 1, characterized in that the additional obstacle taking into account the maneuverability limits of the craft is missing the surface area of a free angular sector starting from the craft and having its opening turned into the direction of motion of the craft.

12. The method as claimed in claim 11, characterized in that, when the distance map takes the form of a grid of cells corresponding to the elements of a database of elevation of the terrain covering the area of travel
5 of the craft, the additional obstacle taking into account the maneuverability limits of the craft is missing the cells that are totally or partially covered by the free angular sector.

13. The method as claimed in claim 11, characterized in that,
10 when the distance map results from the application, to the pixels of an image formed by a map taken from a database of elevation of the terrain, of a distance transform that uses a chamfer mask cataloging the distances of a pixel under analysis with respect to the nearest pixels, called pixels of the neighborhood, and that has axes of propagation (D0, D1, D2, D3, D4)
15 oriented in the directions of the pixels of the neighborhood with respect to the pixel under analysis in the chamfer mask, the free angular sector has its opening oriented along the axis of propagation (D0, D1, D2, D3 or D4) nearest to the direction of motion of the craft.

20 14. The method as claimed in claim 12, characterized in that the free angular sector of propagation is bounded by bisectors of the angles formed by the axes of propagation (D0, D1, D2, D3, D4).